Geological Survey of Ireland Research Programme - Short Call 2015, Final Report Past and Modern Environments of Galway Bay

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Geological Survey of Ireland Research Programme
- Short Call 2015, Final Report -

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Organisation name	Ulster University		
Organisation type:	☒HEI	☐Public Sector (other)	☒Private Sector
Department/section	School of Geography and Environmental Science		

Project Title	Past and Modern Environments of Galway Bay
Contract No.	2015-sc-073

2. **Project information**:

Title of project	Past and Modern Environments of Galway Bay.
Did you make any formal amendment to the project workplan / budget?	☐ yes ☒ no If yes, please specify:

<u>Project Report (*max 1500 words, excluding figures and headings*)</u>:

(i) Objectives and scientific/engineering targets beyond the state of the art

The overarching aim of this project was to extend our knowledge of the sedimentary environments in Galway Bay from post last glacial maximum until the present day.
Specifically the project objective were:
To identify, interpret and assess the timing of sedimentary processes that have occurred in Galway Bay since the end of the last glacial period;
To produce a high resolution geomorphological map of the bay using the INFOMAR multibeam bathymetric and backscatter data;
To reconstruct a detailed seismic sequence stratigraphy of Galway Bay using the INFOMAR pinger (3.5 kHz data).

Objective one: sedimentary processes of Galway Bay.

Twenty-two sediment cores collected in Galway Bay in 2013 and 2014 by Ulster University (Fig. 1) were split, described and analysed as part of the project:

Microfossil samples were collected or picked for radiocarbon dating of the sediments (Table 1). A radiocarbon database for Galway Bay is still being compiled as the final 3 samples have been submitted for analysis but the results have yet to be received (expected delivery date is Thu, Dec. 29). Samples were all submitted to Beta Analytic (http://www.radiocarbon.com) due to the relatively rapid turn-around compared to other analytical laboratories.

The longest cores were run for geochemical analysis under the ITRAX core scanner at BOSCORF in Southampton (http://www.boscorf.org/instruments/itrax-high-resolution-xrf-analysis-sediment-cores) (Cores: 01GC; 01VC to 04VC; 06VC; 07VC; 09VC; 10VC; 12VC to 15VC; 17VC; 18VC; 20VC; 22VC).

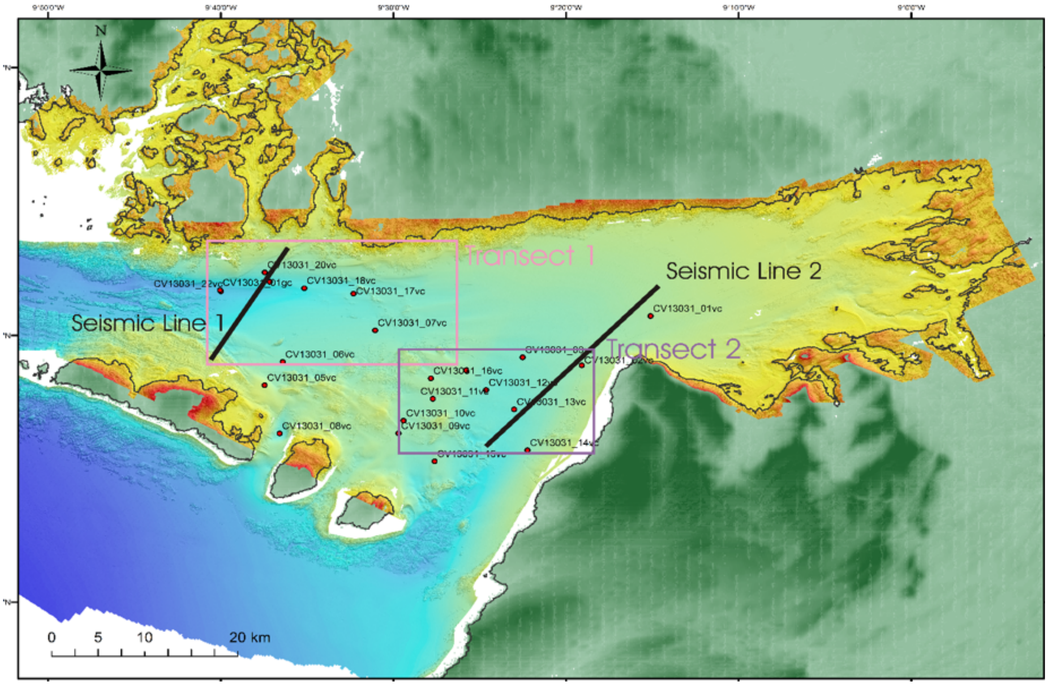

Fig. 1 – Location of sediment cores used in the study. The two areas identified by the rectangles include the cores in Fig. 2.

Table 1. List of samples submitted for radiocarbon dating (samples with asterisk are those still outstanding. Final results are available on request upon publication in peer-reviewed paper.

Sample	Depth (cm)	Material	Lithofacies
CV13031_02VC	279-280	Shell	Silty sand
CV13031_03VC	71	Shell	Turritella layer
CV13031_03VC	72	Shell	Turritella layer
CV13031_06VC	144.5-145.5	Shell	Silty sand
CV13031_07VC	120-121	Shell	Turritella layer
CV13031_10VC	126-127	Shell	Turritella layer
CV13031_10VC	200-201	Shell	Turritella layer
CV13031_12VC	148-152.5	Shell	Diamicton
CV13031_13VC	100-101	Shell	Turritella layer
CV13031_13VC	177-179	Shell	Turritella layer
CV13031_13VC*	235-236	Foraminifera	Silty sand
CV13031_20VC	81-82	Shell	Turritella layer
CV13031_20VC*	117-118	Foraminifera	Diamicton
CV13031_22VC	38-39	Shell	Turritella layer
CV13031_22VC*	269-270	Foraminifera	Sandy Silt
CE14T_03GC	53-54	Shell	Turritella layer

Interpretation of lithofacies resulted in the identification of 3 lithological units, which can be correlated throughout many of the cores in both the North and South sounds (Fig. 2). With the use of AMS radiocarbon dates all of the sedimentary units have been constrained within the Holocene.

The presence of a “Turritella Layer”, so named due to the abundance of the marine gastropod *Turritella* gn. (Fig. 3) was discovered in many of the cores and has been dated to 4,500 to 6,500 years BP. This timeframe correlates well, albeit it is a little younger in Galway Bay, with a similar layer found in other regions in Southern Brittany and Northern Scotland.
X-ray fluorescence (XRF) analysis shows increased ratios of Cl/Fe in younger deposits, showing a general trend of progression from estuarine to open marine conditions. Further analysis of the ITRAX data will be carried out by comparing relative ratios of other elements in order to identify other potentially significant trends in relative ratios.

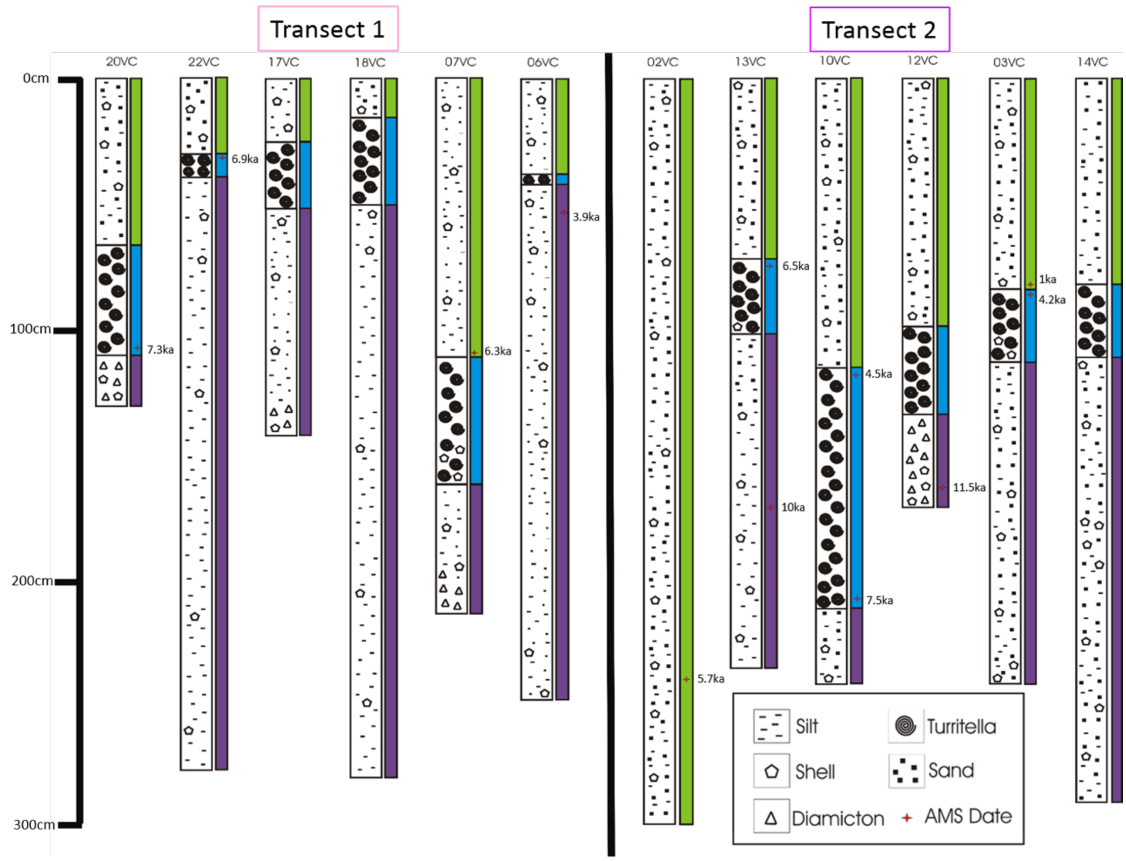

Fig. 2 - Core logs for the longest and more meaningful cores in two transects corresponding approximately to the North and South sounds (Fig. 1). The top lithofacies (green) is a sandy silt and clay facies, which is often followed by a distinct shell hash interlayer (blue) which we named the “Turritella Layer”. This layer is then underlaid by a fine silty sand facies (purple), with a general lower abundance of microfossils and the occurrence of rare gravel and pebble grains.

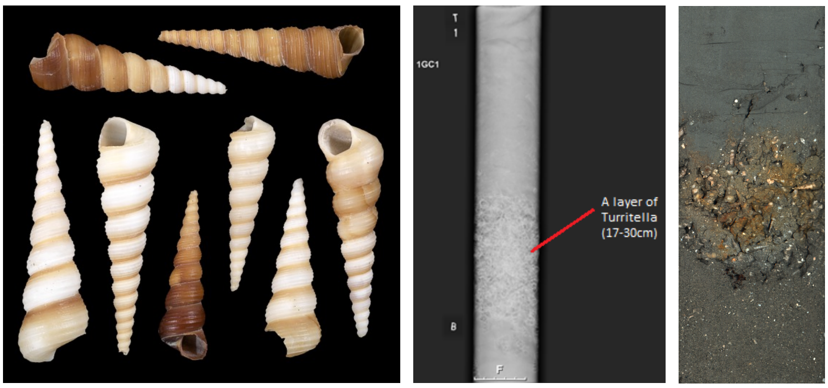

Fig. 4 – Photo of several specimens of Turritella (left). The shells found in Galway Bay are on average 2-4 cm in length. Examples of Turritella layers in the x-radiographs (centre, for core 1GC) and in the core face (right for core 22VC).

Objective two: geomorphological map.

A high resolution geomorphology map (Fig. 6) of the bay was created through the interpretation of the seafloor landforms from the bathymetric and backscatter data. Multibeam data were also analysed in ArcGIS through slope analysis and hydrological tools (Fig. 5).

The map shows the various several types of landforms in Galway Bay, including sediment dunes and erosional scouring, and suggests that tidal and oceanic currents may have played and possibly still play a role in the evolution of these features. Marine terraces are visible near the present day coastline, suggesting a submerged palaeo-shoreline at a much lower sea level. When compared to the model of Bradley et al. (2011) the marine terraces match the position of the coastline around 9kaBP (-23.5m RSL) and 11kaBP (-33m RSL).

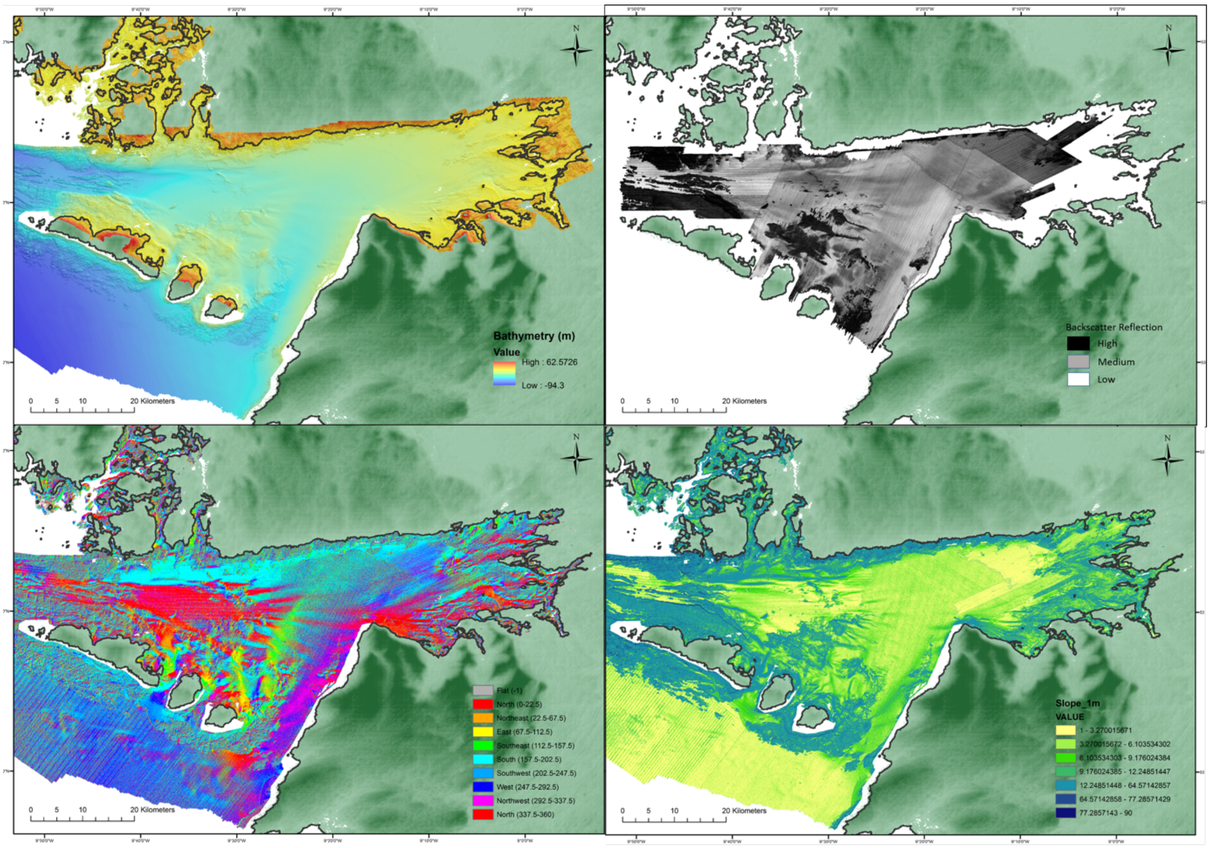

Fig. 5 – Multibeam bathymetric and backscatter data for Galway Bay (top) and examples of the spatial analysis results obtained using ArcGIS tools (bottom).

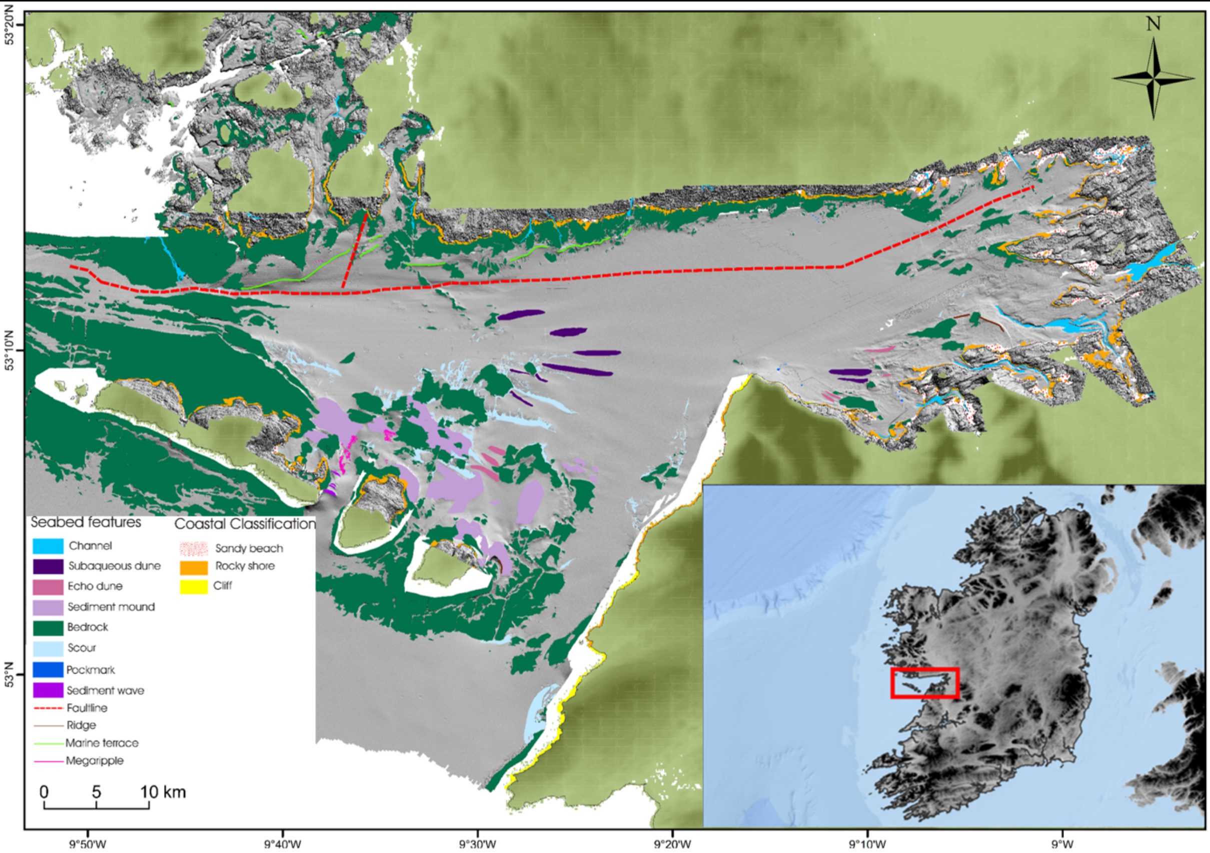

Fig. 6 – Geomorphological map of Galway Bay.

Objective three: seismic stratigraphy.

Analysis of high resolution seismic reflection (3.5 KHz) data in Galway Bay have revealed the presence of three seismic units (Fig. 7). Unit 1, the deepest unit, is the acoustic basement, the folded faulted nature shows the granite of the north and the limestone to the south. It is separated from unit 2 by an upper boundary erosional surface consisting of high reflective strata. Unit 2 represents the oldest preserved sediments and is interpreted to be glacial till, produced during the last glaciation of Ireland. Within this unit infilled channels are visible throughout the study site, but particularly in the inner bay area. This represents a meandering channel system extending from both the Burren and Connemara that widens and deepens towards the outer bay. The nature of the channel system is unclear as it could be related to both glacial and proglacial or fluvial origin. Unit 3 is the uppermost unit and represents deposition and reworking during deglaciation and under present conditions. Within this unit, palaeodeltas and palaeoshorelines are evident, suggesting a sea level lowstand. Sediment cores are entirely contained within this unit.

Isopach maps of each unit have also been produced and can be submitted upon publication of project results (example in Fig. 8).

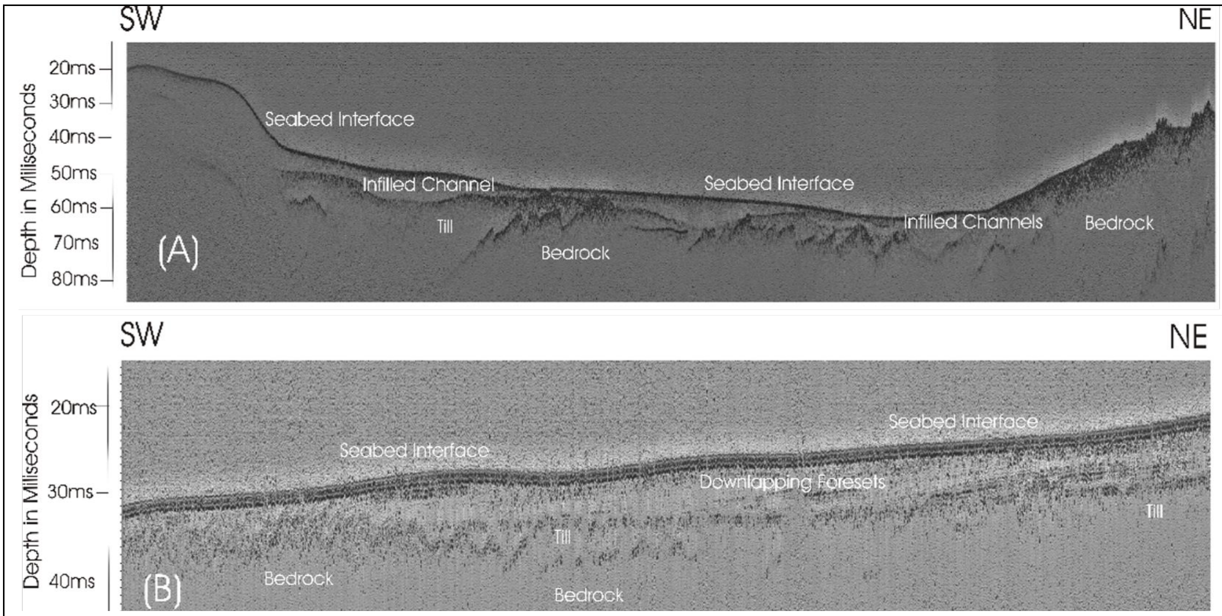

Fig. 7 – Examples of seismic pinger (3.5kHz) data. (A) Infilled palaeochannels visible across the outer bay area; (B) Prograding palaeodelta is visible extending southwest from the present day inner bay area. Position of lines is shown in Fig. 1.

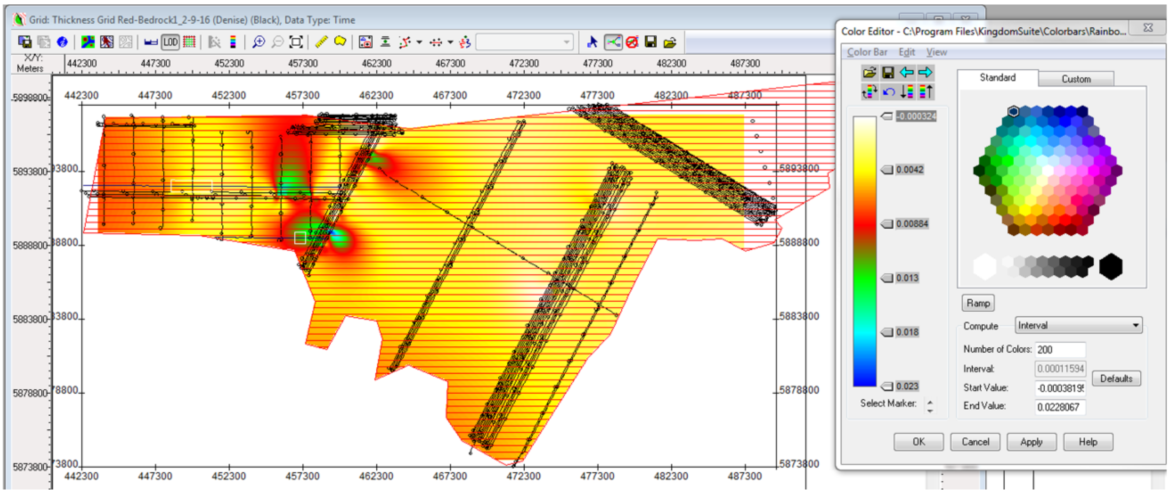

Fig. 8 – Example of isopach processing (Unit 2) in the software Kingdom.

(ii) Implementation (including reference to timelines, milestones, management)

The objectives were achieved within the timeframe of the project and the specific results are shown previously, although the work on the scientific results will continue for few more months through the preparation of 3 manuscripts to be submitted to peer-reviewed journals.

Two issues were experienced during the project.

1. The corruption of an external hard drive caused loss of some interpretation of the seismic data. This meant that some the work had to be redone half way through the project.
2. An underestimation of the time needed to collect the required sample amount of foraminifera for radiocarbon dating meant some delays in the submission of samples to the lab.

Additionally, splitting and initial work on the sediment core showed quite extensive reworking of sediments. Therefore it was decided not to pick microfossil samples for isotopic analysis as the results would have not been reliable.

(iii) Outputs (please use bullet points)

- Detailed seismic stratigraphy of Galway Bay.
- Geomorphological map of Galway Bay.
- Geochronological constraints on the evolution of Galway Bay using AMS radiocarbon dates.
- Production of a Story Map of Galway Bay (this will be delivered once all radiocarbon dates are received and final isopach maps are produced).
- Presentation of results at local and international conferences (see App. 1)
- Draft of 3 separate papers for submission in peer reviewed journals (map to Journal of Maps; seismic data to Geo-Marine Letters; sediment cores to the Holocene). This is an ongoing work that will continue in future months.

Impact/value of the project (M*ax 500 words*):

The research conducted has potential applications for departments across several disciplines.

- The detailed geomorphology map will allow more information on the processes currently shaping the bay and the potential effects of such processes on the coastline. This kind of information is of particular relevance to future exploitation of the region for marine renewable energy and the SMART BAY project. Sedimentological data from the seafloor and the subsurface can also be valuable when assessing the feasibility of offshore installations.
- A detailed high resolution seismic stratigraphy has revealed evidence of submerged channels and other palaeo features, such as deltas, and provided information into past environments across the bay. The AMS radiocarbon database for Galway Bay will allow correlations between the results from this project and the paleoenvironmental information from other areas off the west coast of Ireland allowing for a much better geochronology over a wider area. Together these results will inform the wider scientific community about changed in paleoenvironmental conditions on the western coast of Ireland and can be used for sea level and climate reconstructions and modelling.
- The story map of Galway Bay can be used as an outreach tool to the wider community through easily understood and accessible information that will be freely distributed. Once finalized (an initial draft is available on request) it will be delivered to INFOMAR for publication on the INFOMAR web site.

Appendix 1 – Publications & Presentations:

[Conference Presentation] McCullagh, D., Benetti, S., Plets, R. and Edwards, R. (2016) The changing seascape of Galway Bay. *2016 AGU Fall Meeting, San Francisco, USA*, 12-16-DEC-16

[Conference Presentation] McCullagh, D., Benetti, S., Plets, R. and Edwards, R. (2016) Past and modern environments of Galway Bay Western Ireland. *INFOMAR Seminar 2016 Galway, Ireland*, 19-OCT-16

[Conference Presentation] McCullagh, D., Benetti, S., Plets, R. and Edwards, R. (2016) The changing environment of Galway Bay since the LGM. *Irish Quaternary Association Annual Spring Meeting 2016 Coleraine, Northern Ireland*, 09-APR-16